

10 March 2006

CRUISE RESULTS
NOAA Fisheries Research Vessel DELAWARE II
Cruise No. DE 06-02
Ecosystems Monitoring Survey

CRUISE PERIOD AND AREA

The cruise period was 24 January to 5 February 2006. The NOAA ship DELAWARE II sampled a total of 64 stations located in the Gulf of Maine and Georges Bank for the Winter Ecosystem Monitoring Survey. Of these, 58 were randomly stratified stations, five were fixed stations in the Gulf of Maine and two were non-randomly chosen stations, placed to improve coverage when the vessel missed random stations due to weather constraints. Three of the fixed stations were located in the Wilkinson, Jordan and Georges basins, one was at the site of a proposed liquefied natural gas (LNG) terminal outside of Boston Harbor, and one hydrographic (CTD only) station was in the Northeast Channel (Figure 1).

OBJECTIVES

The primary objective of the cruise was to assess changing biological and physical properties which influence the sustainable productivity of the living marine resources of the Gulf of Maine and Georges Bank portions of the northeast continental shelf ecosystem.

Secondary objectives of this cruise involved the following sampling:

- CTD casts to within 5 meters of the bottom in deep basin areas of the Gulf of Maine and Northeast Channel to provide hydrographic data detailing the incursion of Labrador Current Water into the Gulf of Maine,
- Sampling at the site of a proposed LNG terminal to gather baseline biological and hydrographic data,
- collection of samples for zooplankton genetics (genome) studies,
- collection of surface water at four sites to sample marine microbial and viral populations for DNA analysis.
- examination of plankton samples for concentrations of Calanus finmarchicus to correlate with right whale sightings.

METHODS

The survey consisted of 58 randomly stratified stations at which the vessel stopped to lower instruments over the side. Sixty random stations were planned for the cruise, with 30 in the Gulf of Maine and 30 on

Georges Bank, but one station was dropped from the Gulf of Maine and one from Georges Bank due to high winds and seas. A non-random station was done in each of those two areas to help improve coverage when conditions improved. Four additional non-random stations were completed in the Gulf of Maine area to document characteristics of deep basin water transported in by the Labrador Current. Another non-random station in the Gulf of Maine provided baseline hydrographic and biological data from a proposed LNG terminal site outside of Boston Harbor. A total of 65 stations were sampled on the cruise. Key parameters measured included ichthyoplankton and zooplankton composition, abundance and distribution, water column temperature and salinity, and along-track chlorophyll-*a* fluorescence. Zooplankton genetics (zoogen) samples were collected at ten stations; five in the Gulf of Maine, and five on Georges Bank.

Double oblique tows using the 61-centimeter bongo sampler and a Seabird CTD were made at 64 stations. Tows were made to approximately 5 meters above the bottom, or to a maximum depth of 200 meters, at all stations with the exception of the Northeast Channel station, which was designated as a CTD only station. All tows were conducted at a ship speed of 1.5-2.0 knots.

Plankton sampling gear consisted of a 61-centimeter diameter aluminum bongo frame with two 335-micron nylon mesh nets. At the randomly designated zoogen stations, a 20-centimeter diameter PVC bongo frame fitted with paired 165-micron nylon mesh nets was put on the towing wire one half meter above the Seabird CTD with a wire stop. A 45-kilogram lead ball was attached by an 80-centimeter length of 3/8-inch diameter chain below the aluminum Bongo frame to depress the sampler. A digital flowmeter was suspended within the mouth of each sampler to determine the amount of water filtered by each net. No flowmeters were used in the 20-cm bongos. The plankton sampling gear was deployed over the starboard side of the vessel by means of a conducting-cable winch and a hydraulic A-frame. After each tow the CTD unit was left plugged in to the tow cable and brought into the heated sheltered work area of the aft deck. The bongo frame and nets were also brought to this area for rinsing out the samples, and were left there until the subsequent station. This arrangement prevented the equipment from getting covered with sea-spray and icing up, and was also a much safer environment for the deck person retrieving the samples to work in. The 61-centimeter bongo plankton samples were preserved in a 5 % solution of formalin in seawater. The zooplankton genetics samples were preserved in 95 % ethanol, which was changed once 24 hours after the initial preservation. Tow depth was monitored in real time with a Seabird CTD profiler. The Seabird CTD profiler was hard-wired to the conductive towing cable, providing simultaneous depth, temperature, and salinity data for each plankton tow.

At two stations in the Gulf of Maine, and two stations on Georges Bank, surface water samples were collected for microbial DNA analysis. Two hundred liter surface water samples were passed through a 25 micron pre-filter and size-fractionated by filtering through three subsequent membrane filters of increasingly fine mesh: 3 microns, 0.8 microns and 0.1 microns. Viruses were concentrated from the 0.1 micron filtrate by tangential flow filtration (Figure 2). The filtered microbial and viral components were frozen in liquid nitrogen for analysis by high throughput DNA sequencing and whole genome shotgun assembly techniques ashore at the Venter Institute. This work is part of a larger program to evaluate marine microbial biodiversity throughout the world's oceans (www.sorcerer2expedition.org). The surface water was initially planned to be pumped aboard the vessel by a 12 volt bilge pump but this proved inadequate for the task. A peristaltic pump did manage to bring in the first sample, but was slow

and took over half an hour to fill the 240 liter container. The ship's crew then used the ship's electric dewatering pump deployed by hand from the port side of the vessel to collect the last three samples (Figure 3).. This high capacity unit was able to fill the 240 liter container in less than two minutes, which greatly speeded up the collection process (Figure 4).

After the cruise, samples were measured for settled volumes (Table 1). Stations with large amounts of *Calanus finmarchicus* were noted and the data forwarded to Tim Cole, of the NEFSC Protected Species Branch, Large Whale Group.

Continuous monitoring of the seawater salinity, and chlorophyll-a level, was done at a depth of 3.7 meters along all of the cruise track by means of a thermosalinograph, and a flow-through fluorometer. The Scientific Computer System (SCS) recorded the output from both the thermosalinograph, and the fluorometer at 10 second intervals. The data records were given a time-date stamp by the GPS unit.

Samples for Seabird CTD salinity data calibration were obtained on the 12-6 watch using a 1.7 liter Niskin bottle taking a water sample from an isohaline portion of the water column. Calibration of the CTD salinities from the surface flow-through system was undertaken on the 6-12 watch. Sample analysis for these calibrations followed the protocol outlined in the Ecosystem Monitoring Program Operations Manual.

RESULTS

A summary of routine survey activities is presented in Table 1. Areal coverage for the cruise is shown in Figure 1. The DELAWARE II sailed at 1300 hours EST on Tuesday January 24. The vessel sailed through the Cape Cod Canal and headed east for an offshore station in the middle of the Gulf of Maine to pick up as many offshore stations as possible prior to some weather that was forecast for the area. The vessel worked its way westward towards more protected water all day Wednesday, picking up its first microbial DNA and zooplankton genetics samples. As winds picked up on Thursday it proceeded northeast along the New England coastline sampling inshore stations. A second microbial DNA sample was obtained from inshore coastal Maine waters on Thursday. By Friday the winds abated somewhat and the vessel headed offshore towards the Jordan Basin and then on into Canadian waters on Saturday, making excellent progress under steadily improving sea conditions. On Sunday, 29 January, the DELAWARE II had completed most of the GOM stations and four Georges Bank shoal area stations. One station located in the Bay of Fundy was dropped to save time. With storm force conditions forecast for Tuesday, the vessel worked its way back towards Woods Hole on Monday, picking up the last six GOM stations, the last zooplankton genetics sample from the Gulf of Maine and the last microbial DNA sample of the cruise prior to docking in Woods Hole at 1500 on Monday, 30 January 2006.

The DELAWARE II offloaded some scientific personnel and remained in Woods Hole until winds abated on Thursday, 2 February and it sailed at 0900 hours. The vessel headed east through Great Round Shoal Channel toward Georges Bank, where sampling was conducted from west to east along the southern flank. No microbial or viral DNA samples were taken on this part of the cruise. By early Saturday, 4 February, the DELAWARE II had already reached the northeast peak of Georges Bank, and continued back into the Gulf of Maine to sample three stations that were missed on the first part of the cruise. After

completing sampling operations at these GOM stations the vessel returned to Georges Bank to continue sampling and worked its way back west, across the middle of the bank and towards Woods Hole. Five zooplankton genetics sample were collected on Georges Bank, but one random ecosystem monitoring station was missed in order to get to Woods Hole prior to the arrival of a storm that was forecast to reach Cape Cod on Monday. A non-random station within the same stratum was substituted and sampled prior to returning to Woods Hole. This was the last station for the DE0602 cruise, and was completed before 0600 hours on Sunday 5 February 2006. The vessel docked at the NMFS laboratory in Woods Hole at 1530 hours that same day. Plankton sampling supplies from the DELAWARE II were then placed aboard the ALBATROSS IV in preparation for its departure the following day on the first leg of the Winter Trawl Survey.

DISPOSITION OF SAMPLES AND DATA

All samples and data, with the exception of the zooplankton genetics samples, microbial DNA samples and the Seabird CTD data, were delivered to the Ecosystems Monitoring Group of the NEFSC, Narragansett, RI, for quality control processing and further analysis. The zooplankton genetics samples were taken from the vessel by Nancy Copley of the Woods Hole Oceanographic Institute. The microbial DNA samples were taken to the J. Craig Venter Institute in Rockville, MD by Shannon Williamson. The CTD data were delivered to the Oceanography Branch of the NEFSC, Woods Hole, MA. Copies of the CTD logs were retained by the Ecosystems Monitoring Group in Narragansett. Calanus volume information was forwarded to Tim Cole after the cruise was completed.

SCIENTIFIC PERSONNEL

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Table 1. STATION OPERATION REPORT FOR CRUISE DE0602

CAST	STA.	Date (GMT)			TIME (GMT)		LAT	LONG	DEPTH	OPER. B=bongo W=water M=micro Z=zoogen N=nitrogen V=vertical cast (CTD only) CO=Calanus observed/vol
		mm	dd	yy	hr	min				
1	1	1	25	2006	10	48	4254.2	6813	177	B
2	2	1	25	2006	15	24	4243.9	6840.8	191	B, M1, CO/ 128cc
3	3	1	25	2006	18	17	4231.2	6908.6	211	W1
4	3	1	25	2006	18	31	4230.9	6908.1	208	B, CO/ 221cc
5	4	1	25	2006	20	23	4242.3	6918	190	B, CO/ 345cc
6	5	1	25	2006	21	11	4240	6922.9	219	V1
7	5	1	25	2006	21	36	4240	6923	226	B, CO/ 190cc
8	6	1	25	2006	23	31	4238.8	6944.8	238	V2
9	6	1	25	2006	23	49	4238.5	6945	243	B, Z1, CO/ 326cc
10	7	1	26	2006	1	55	4250.7	7000.3	182	B, CO/ 326 cc
11	8	1	26	2006	5	24	4226.4	7030.4	55	W2
12	8	1	26	2006	5	36	4226.4	7030.4	55	B
13	9	1	26	2006	6	17	4224.7	7035.2	86	B
14	10	1	26	2006	9	16	4241.3	7040.8	18	B
15	11	1	26	2006	16	15	4328.7	6946.8	130	B, CO/ 190cc
16	12	1	26	2006	20	33	4350.3	6905.6	62	W3
17	12	1	26	2006	20	53	4350	6905.5	65	B
18	13	1	27	2006	0	47	4358.9	6833.3	85	B
19	14	1	27	2006	15	56	4407.5	6758.3	94	B, M2
20	15	1	28	2006	0	35	4338.8	6800	198	B, Z2, CO/ 302cc
21	16	1	28	2006	2	37	4333.7	6814.2	180	B, CO/ 236cc
22	17	1	28	2006	5	33	4324	6742.1	247	W4
23	17	1	28	2006	5	52	4323.9	6741.9	246	B, CO/ 236 cc
24	18	1	28	2006	9	57	4340.9	6657.3	146	B
25	19	1	28	2006	13	13	4359.2	6712.9	166	B
26	20	1	28	2006	17	7	4347.7	6625.8	53	W5
27	20	1	28	2006	17	27	4347.6	6625.3	68	B
28	21	1	28	2006	23	13	4309.1	6710.4	188	B, Z3
29	22	1	29	2006	1	32	4308.6	6736.1	187	B
30	23	1	29	2006	5	11	4236.3	6722.6	266	W6
31	23	1	29	2006	5	21	4236.2	6722.4	267	V3
32	23	1	29	2006	5	43	4236.1	6721.9	267	B
33	24	1	29	2006	9	36	4241.5	6634.7	166	B
34	25	1	29	2006	12	24	4224.9	6659.5	361	W7, M3
35	25	1	29	2006	12	55	4224.7	6700	361	B, Z4,
36	26	1	29	2006	15	30	4206.4	6646.4	70	B
37	27	1	29	2006	18	3	4151.3	6710.2	59	W8
38	27	1	29	2006	18	15	4151.2	6710	57	B
39	28	1	29	2006	20	52	4153.5	6742.4	36	B
40	29	1	29	2006	21	26	4149.4	6744.8	35	B

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									m	
41	30	1	29	2006	23	45	4206.2	6805.2	218	B, Z5
42	30	1	30	2006	0	12	4206.6	6804.4	219	V4
43	31	1	30	2006	1	44	4216	6818.5	205	B, CO/ 172cc
44	32	1	30	2006	3	20	4211.3	6829.9	153	B
45	32	1	30	2006	3	54	4211.1	6830.4	160	B
46	33	1	30	2006	5	34	4214.2	6845.9	206	W9
47	33	1	30	2006	5	43	4214.1	6845.7	198	B, CO/ 172cc
48	34	1	30	2006	10	42	4128.7	6906	143	B, M4, CO/ 23cc
49	35	1	30	2006	12	45	4138.8	6928.8	107	B
50	36	2	3	2006	0	39	4038.6	6834.7	60	B, Z6
51	37	2	3	2006	2	17	4051.1	6824.9	48	B
52	38	2	3	2006	2	55	4048.9	6821	55	B
53	38	2	3	2006	3	20	4048.8	6821	55	B
54	39	2	3	2006	5	48	4031.3	6806.8	109	W10
55	39	2	3	2006	5	54	4031.4	6807	108	W11
56	39	2	3	2006	6	6	4031.2	6806.9	109	B
57	40	2	3	2006	9	23	4038.5	6725.1	93	B
58	41	2	3	2006	10	46	4048.4	6718.8	93	B
59	42	2	3	2006	11	33	4043.9	6712.9	96	B
60	43	2	3	2006	12	30	4038.8	6705.3	166	B
61	44	2	3	2006	14	1	4041.3	6651	243	B, Z7
62	44	2	3	2006	14	27	4041	6650.4	267	V5
63	45	2	3	2006	17	18	4058.6	6630.9	132	W12
64	45	2	3	2006	17	24	4058.6	6631.2	132	B
65	45	2	3	2006	17	48	4058.6	6631.1	133	B
66	46	2	3	2006	19	4	4108.7	6635	90	B
67	47	2	3	2006	23	59	4140.9	6546.7	499	V6
68	47	2	4	2006	0	41	4141.5	6546.8	494	B, Z8
69	48	2	4	2006	4	47	4213.5	6546	223	W13
70	49	2	4	2006	6	2	4213.8	6532.8	113	B
71	50	2	4	2006	9	23	4235.9	6558.6	82	B
72	51	2	4	2006	12	21	4206.1	6604.4	144	B
73	51	2	4	2006	12	41	4206	6604.6	133	B
74	52	2	4	2006	13	25	4203.5	6610.1	91	B, Z9
75	53	2	4	2006	15	28	4144	6622.6	79	B
76	54	2	4	2006	16	20	4141.5	6630.5	77	W14
77	54	2	4	2006	16	30	4141.7	6630.6	76	B
78	55	2	4	2006	21	13	4123.7	6636	87	B
79	56	2	4	2006	22	50	4126.2	6652.7	70	B
80	57	2	5	2006	0	8	4116.4	6658.7	67	B

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										B=bongo W=water M=micro Z=zoogen N=nitrogen V=vertical cast (CTD only) CO=Calanus observed/vol
81	58	2	5	2006	1	7	4118.5	6708.2	58	B
82	59	2	5	2006	2	5	4111.4	6714.5	57	B
83	60	2	5	2006	3	22	4106.4	6730.1	58	B, Z10
84	61	2	5	2006	4	29	4116.3	6734.8	44	B
85	62	2	5	2006	5	8	4121.2	6736.8	40	W15
86	62	2	5	2006	5	15	4121.4	6736.8	40	B
87	63	2	5	2006	7	15	4126.1	6802.7	38	B
88	64	2	5	2006	8	44	4127.1	6819.7	54	B

TOTALS: Bongo Casts = 67*
 Bongo 6B3Z Samples = 65
 Bongo 6B3I Samples = 65
 Water Samples = 15
 Vertical Casts = 6
 CTD Casts = 88
 Zoogen samples = 10
 Microbial DNA samples = 4
Calanus observations = 13

*Note: Two bongo casts did not produce samples due to equipment problems.

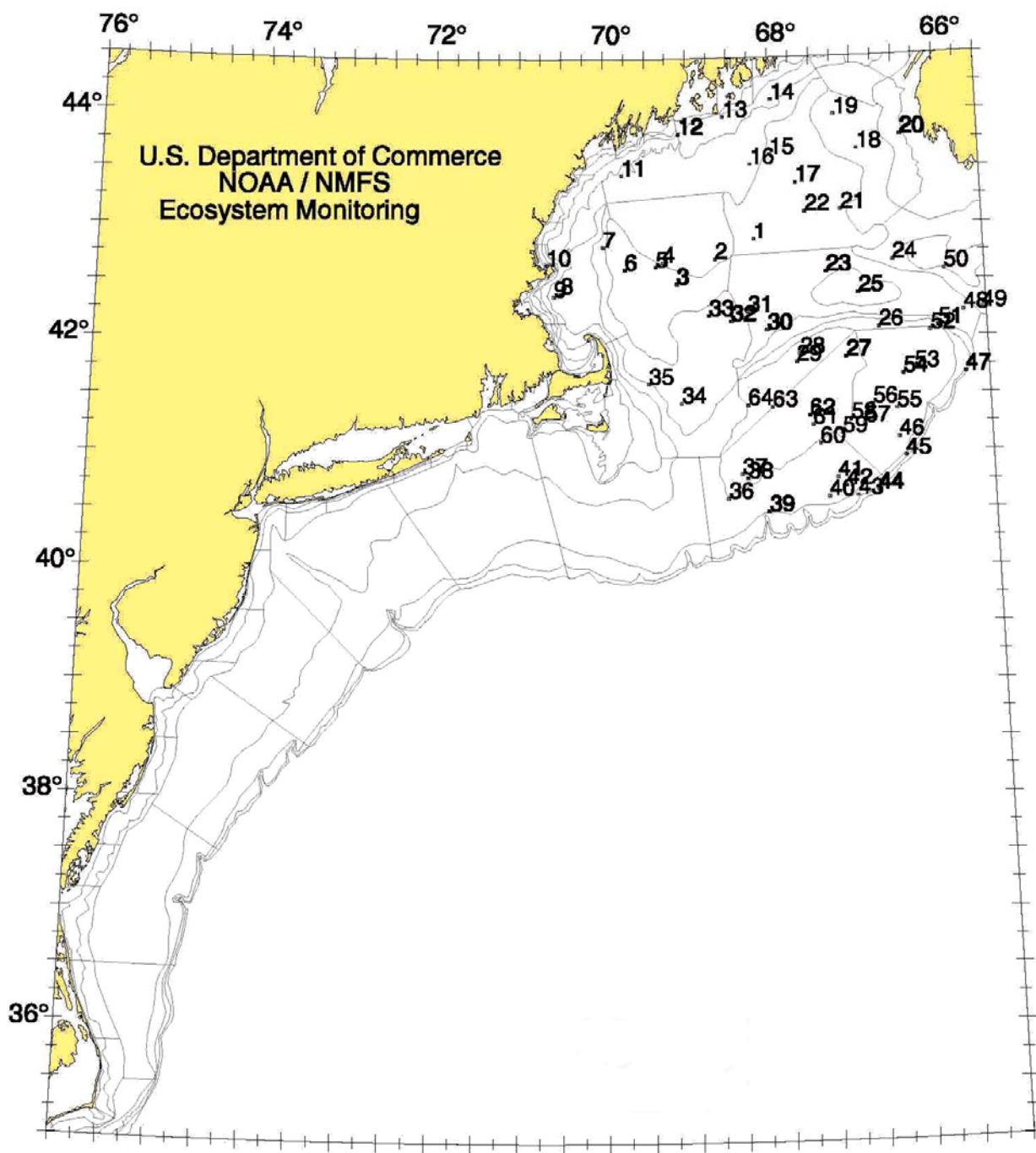


Figure 1. Station locations numbered consecutively for Winter Ecosystems Monitoring Cruise DE 06-02 Jan 24 - Feb 5 2006.



Figure 2. Filtration Setup aboard Delaware II 0602 Cruise.



Figure 3. De-watering Pump used for Microbial Sampling aboard Delaware II 0602 Cruise.



Figure 4. Microbial Sample Barrel being filled by De-watering Pump aboard Delaware II 0602 Cruise.